

Space Weather Technical Forecast

Issued on Friday, 02 September 2022 at 12:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Slight Chance of M-class flares (R1-R2 Blackouts). G1/Minor Geomagnetic Storm expected on day 3 (4th Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low, with several Common class flares observed. Of the four active regions on the visible disc, AR3089 remains the largest and magnetically complex region and remains in a stable configuration. There are also two other numbered sunspot regions on the visible disc: AR3086 has recently faded near the southwest limb and AR3092 located near the southeast limb is a simple and inactive region. The last unnumbered region, also in the far southeast, is currently relatively small, magnetically simple and stable. No new coronal mass ejections (CMEs) have been observed from available imagery, despite a small filament eruption during the afternoon of 1 Sep, from the eastern hemisphere.

Solar Wind / Geomagnetic Activity: Solar winds started at elevated level around 550 km/s due to a high speed stream (HSS) from coronal hole 17. Solar winds declined erratically to reach mostly slightly elevated levels after 02/0200 UTC. Density was near or slightly above average. Total interplanetary magnetic field strength was weak throughout, as was the north-south component, Bz, which became occasionally negative reaching -6nT at 02/0710 UTC and remained in the range +5/-6 nT. The Phi angle was negative (towards the Sun) with a switch to positive (away from the sun) around 02/0700 UTC. Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured at GEO by the satellite GOES-16, is at background levels. The high energy electron flux (greater than 2 MeV) was at background to moderate levels. The 24-hour integrated electron fluence remained well below the Active threshold (1e8 integrated pfu) with 2.02e6 integrated pfu observed at 02/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is Low. There is a slight chance (10-20%) of isolated M-class flares, mainly from AR3089. However, a new region may rotate onto the northeast limb within the next couple of days, potentially increasing the probabilities of a significant flare.

Solar Wind / Geomagnetic Activity: Solar winds are expected to continue to gradually decline today (2nd September). Solar wind speed increases are expected early day 2, or more likely early day 3 (4th) due to the connection with two consecutive high speed streams. In addition a marked filament eruption observed on 30 August produced a CME which may give a glancing blow at Earth, most likely later tomorrow (3rd September), however confidence is low regarding this.

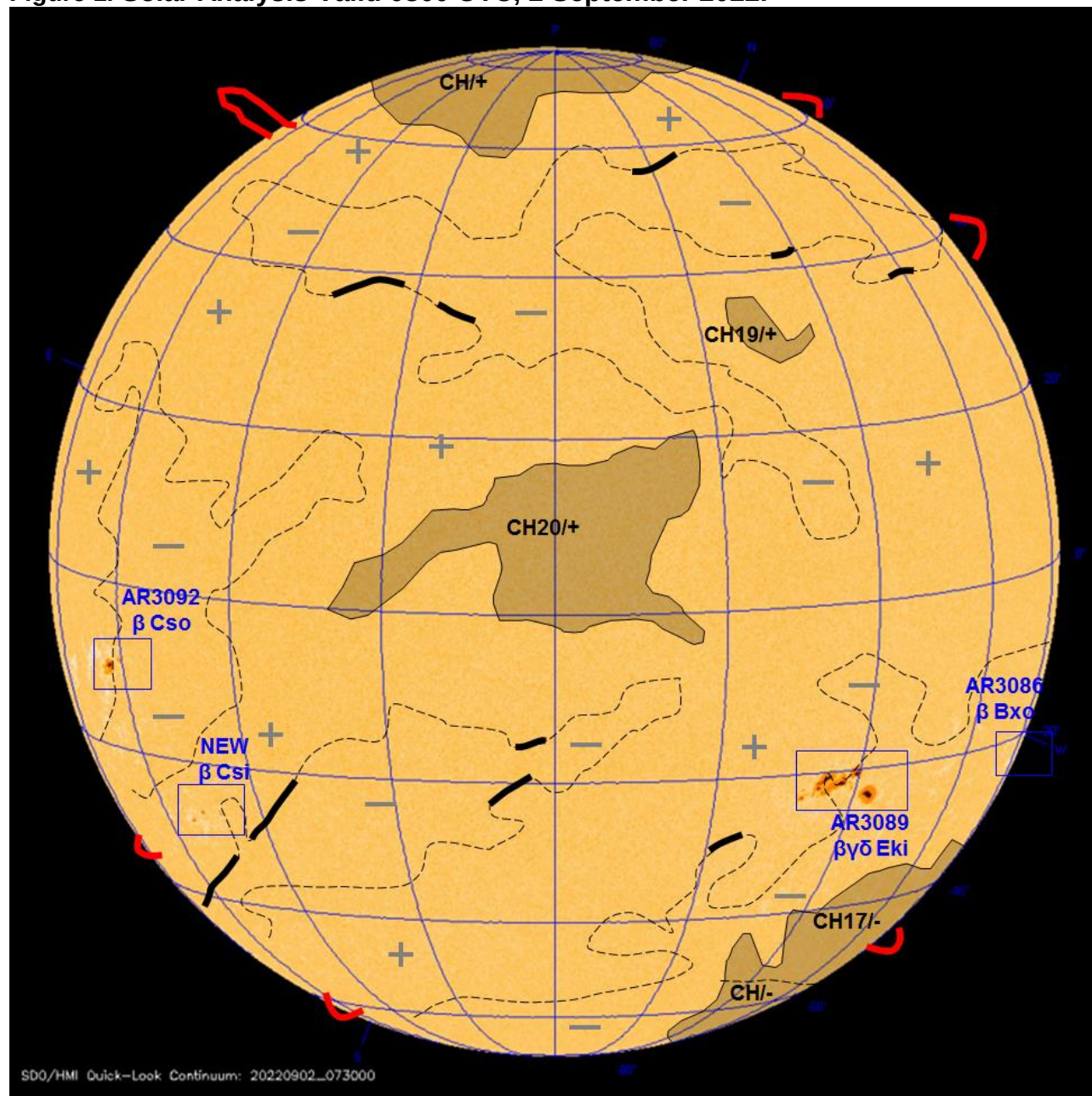
Geomagnetic activity is expected to be Quiet (Kp 0-2) today, with perhaps an isolated Active (Kp 4) interval. Geomagnetic activity is then expected to become Unsettled (Kp 3) tomorrow,

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becoming during day 3 (4th) Active to G1/Minor Storm (Kp 4-5), with an isolated G2/Moderate storm interval (Kp 6) possible, as a result of a substantial coronal hole high speed stream arriving from CH20 and any preceding CIR (co-rotating interaction region).

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels. The high energy (greater than 2 MeV) electron flux is expected to be mostly at moderate levels today, tomorrow and also day 4, perhaps briefly reaching high levels at the peak of the diurnal cycle. In-between for days 2 and 3 (3rd and 4th) background to moderate levels are expected. The corresponding 24 hour fluence levels are likely to remain below the Active threshold, with a rising trend later in the period.

Figure 1. Solar Analysis Valid 0800 UTC, 2 September 2022.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Solar winds are likely to decline before increases are expected early day 2, or more likely early day 3 (4th) due to the connection with initially CH19 and then CH20. Both of these features are positive, and the autumn equinox is approaching. Also, CH20 appears larger and stronger compared to the previous rotation, when wind speeds reached around 580 km/s at times and a G1/Minor geomagnetic storm occurred. Therefore the HSS from these features are expected to have a slightly stronger impact. In addition a marked filament eruption observed on 30 August produced a CME which may give a glancing blow at Earth, most likely later tomorrow (3rd September), however confidence is low regarding this.

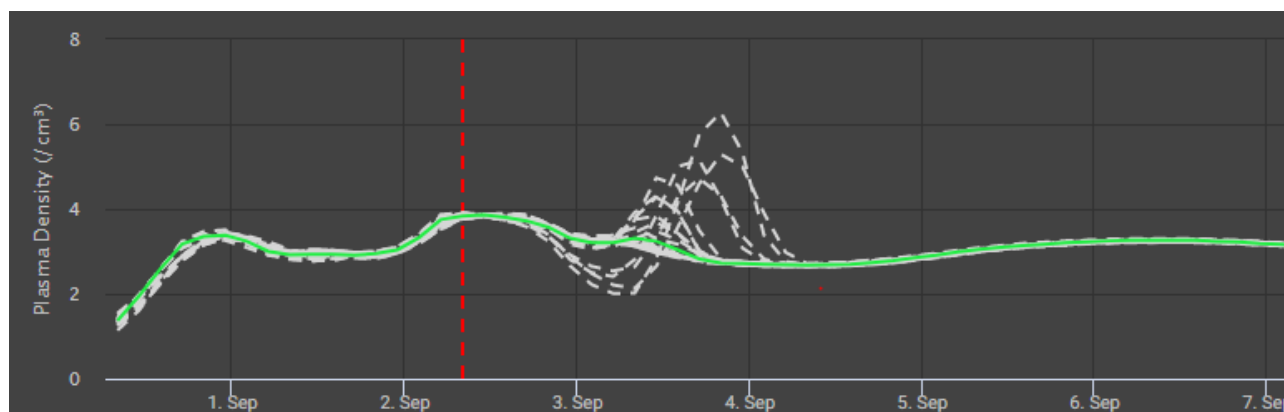
Geomagnetic activity is expected to be Quiet, with perhaps an isolated Active (Kp 4) interval. Geomagnetic activity is then expected to become Unsettled (Kp 3) tomorrow, becoming during day 3 (4th) Active to G1/Minor Storm (Kp 4-5), with an isolated G2/Moderate storm interval (Kp 6) possible, as a result of a substantial coronal hole high speed stream arriving from CH20 and any preceding CIR (co-rotating interaction region).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	30	80	60
Strong	G3	No	1	1	10	10
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
31/0204	Partial halo	Filament eruption	SE Quadrant	420 km/s	02/1800UTC	Limites shock – glancing blow

Figure 2: Met Office ENLIL ensemble output showing likely arrival times of CME.



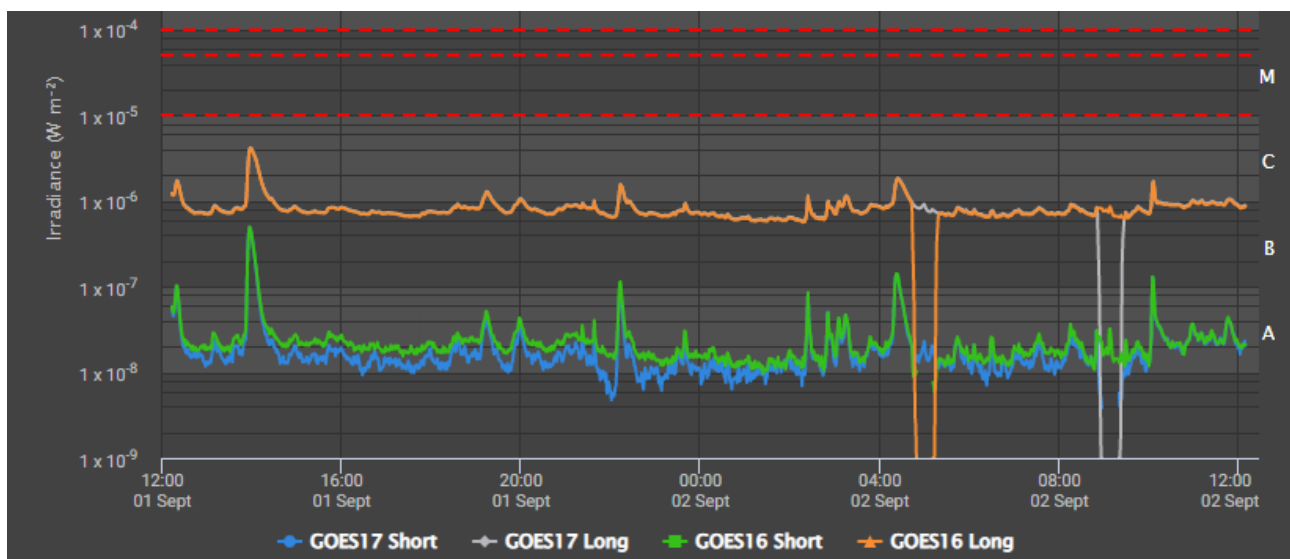
Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the last 24 hours with no M-class flares observed. The most significant active region is currently AR3089 (Eki/Beta-Gamma-Delta), which is large, but has

produced limited solar activity in recent days, with relatively organised magnetic looping. This provides the greatest flare risk though, with a slight chance (10-20%) of M-class flares. The remaining regions presently on the visible side of the solar disc are currently not considered to offer a notable risk. Looping, as clearly seen from SDO -aia 171 imagery, on the eastern limb, suggests a potential increase in activity, with further active regions probably rotating onto the Earth-facing disc. These will be monitored and assessed for an increasing risk over the coming days, and this risk has been reflected in the probabilities in the table above.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	10	20	30
Very Active	R3 to R5 X Class	No	5	1	5	5

Figure 3: X-ray flux plot at GEO as measured by GOES satellites.



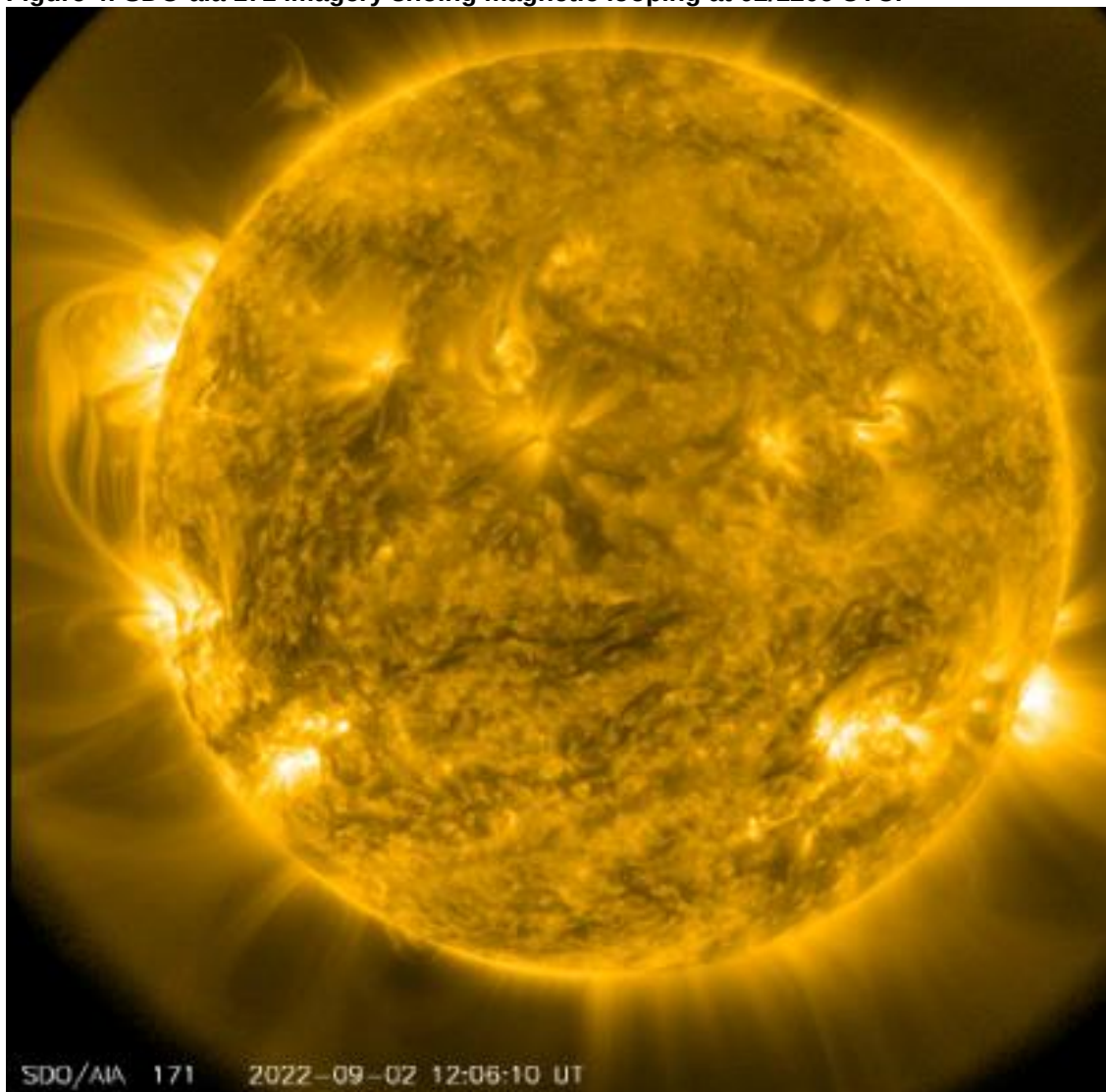
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) remains at background values. AR3089 (Eki/Beta-Gamma-Delta despite apparent stability, continues to present a slight chance of a proton event at Earth should there be any significant flaring. This risk will continue as the region rotates further across the southwestern quadrant.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 4: SDO-aia 171 imagery shoing magnetic looping at 02/1206 UTC.



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) might exceed the high ($1\text{e}3$ pfu) threshold tomorrow and day 4 (5th) as solar winds decline and radiation belts relax into their natural orbits. However, elevated solar winds from high speed streams and potential periods of heightened geomagnetic activity are expected to inhibit the electron flux during day 3 (4th). The corresponding 24 hour fluence levels are likely to remain below the Active threshold, with a rising trend later in the period. Therefore the Met Office REFM output is considered to be offering reasonable guidance.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^8$	No	5	20	10	40
Very Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output indicating a likely rise around 5 Sep.

